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AERIAL SEEDING SITKA SPRUCE AND WESTERN HEMLOCK ON A CUTOVER AREA IN SOUTHEAST ALASKA

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INTRODUCTION

Timber in southeast Alaska is ordinarily harvested by clearcutting in large blocks. Restocking is seldom a serious problem since high-lead or tractor logging methods usually prepare a suitable seedbed, the summer climate is generally mild, and in most cases sufficient seed is disseminated from surrounding timber. When such seed sources are lacking, aerial seeding may be used to sow large areas at relatively low cost. This report describes the effectiveness of aerial seeding as tested at Katlian Bay near Sitka, Alaska.

Katlian Bay is a steep-sided inlet typical of many timber-producing areas in southeast Alaska. Before logging, the hillsides supported merchantable stands of old-growth timber in a mixture of about 67 percent western hemlock *(Tsuga heterophylla* (Raf.) Sarg.), 28 percent Sitka spruce *(Picea sitchensis* (Bong.) Carr.) and 5 percent Alaska-cedar *(Chamaecyparis nootkatensis* (D. Don) Spach.). Old-growth stands with a somewhat greater percentage of spruce and virtually no cedar grew on the flat valley bottom at the bay's head.

A high-lead cable system and floating skidder were used to log the slopes on both sides of Katlian Bay, the south-facing slope in 1958-59, the north-facing slope in 1959-60. The flat valley-bottom land at the head of the bay was logged in 1960 with high-lead cable and tractor.

On October 27, 1960, 651 acres of cutover land were seeded with western hemlock and Sitka spruce. A regeneration survey was made one year later to evaluate reproduction resulting from seeding. At that time all cutover areas were found to be well stocked with natural reproduction, including both residual seedlings that had survived logging and seedlings resulting

from natural seed dispersal before the fall of 1960. However, the test attempts only to evaluate the result of aerial seeding in terms of number and distribution of seedlings established at the end of the first growing season. Thus, only hemlock and spruce seedlings germinating during 1961, the year following seeding, are considered in detail.

METHODS

Clearcuttings on three aspects were helicopter-seeded, with adjacent areas left unseeded for comparison (fig. 1). Western hemlock and Sitka

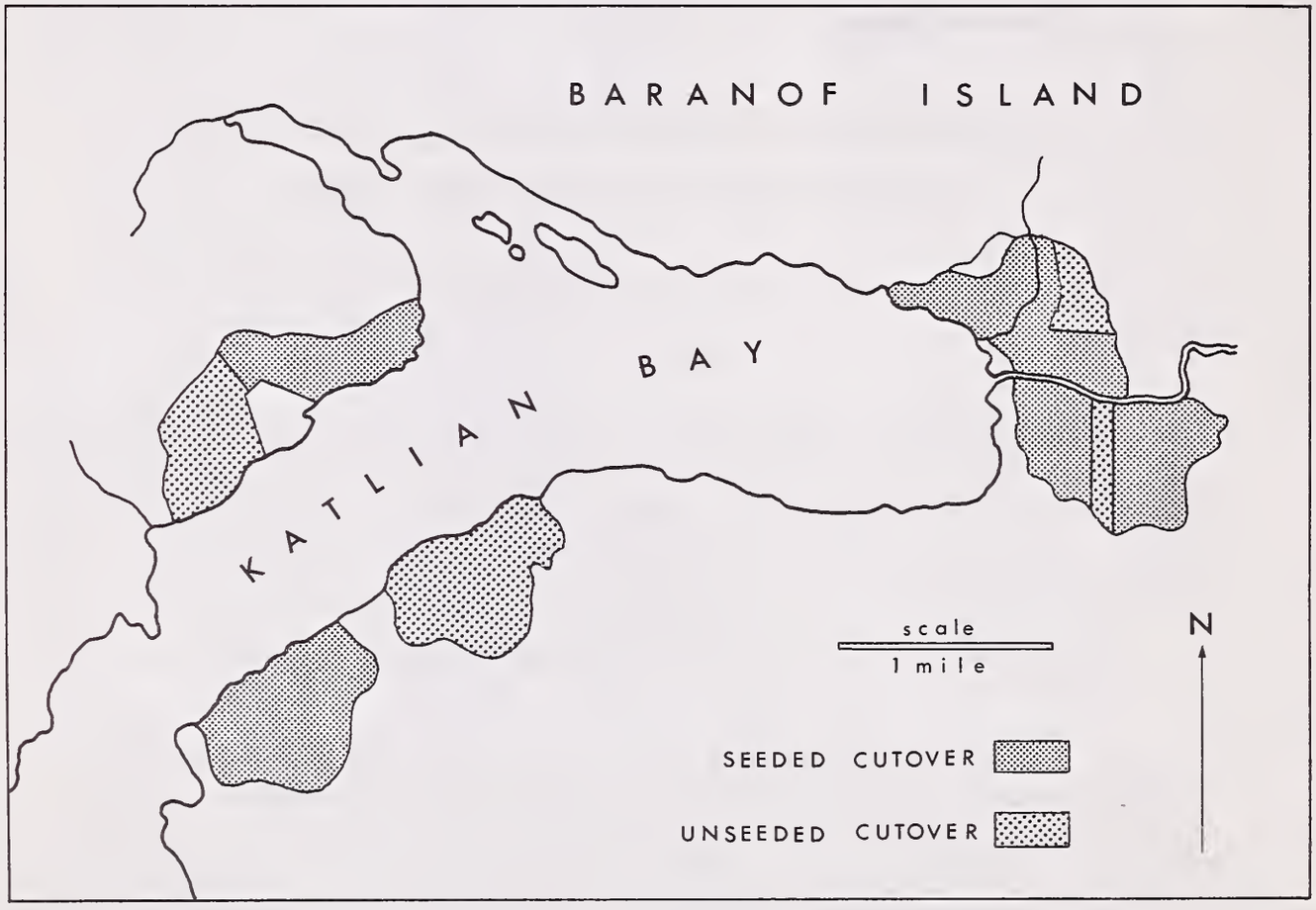

Figure 1.--Seeded and unseeded cutover areas, Katlian Bay, Alaska

spruce seed was mixed in a ratio of two pounds spruce to one pound hemlock and sown at the rate of one-third pound per acre. Seed was collected near Juneau, Sitka, and Hollis, Alaska, between 1956 and 1959, and was processed and stored by a commercial seed-handling firm. Live seed, as determined by the processor, ranged from 44 percent to 80 percent with an average of 60 percent. Before sowing, seed was treated with endrin and aluminum powder for protection from seed-eating mammals and birds.

Natural seedfall was estimated from 24 box-type seed traps, each 6 square feet in area, placed on north- and south-facing hillsides in the fall of 1960; natural seedfall was not measured on the valley bottom.

One year after sowing, seedling counts were made on 75 circular 4-milacre sample plots spaced along lines in each of the 3 paired study blocks. Plots were well distributed on the south-facing blocks and the north-facing unseeded block. On the north-facing seeded block, plots were grouped toward the west end since logging was still in progress on the eastern part during natural seedfall in 1960-61. Plots were grouped more closely on the valley bottom because the unseeded strip was only 6.5 chains wide. The seeded portion of this area was sampled on a strip similar in width and adjacent to the unseeded strip.

A plot was considered to be stocked with new 1961 seedlings if at least one was present; seedlings were counted on a milacre subplot to determine the number per acre. All seedlings germinating in 1961 were considered to be either from sown seed or from seed naturally dispersed from adjacent timber during the fall and winter of 1960-61. Isaac[1/] has shown that neither hemlock nor spruce seed will germinate after more than one year on the forest floor.

RESULTS

Aerial-Sown Seed and Natural Seed Dispersal

The 257 acres of hillside cuttings were sown with 86 pounds of mixed spruce and hemlock seed, and 131 pounds were sown on the 394 acres of valley-bottom land. Based on average numbers of seed per pound, 297,000 for hemlock and 210,000 for spruce,[2/] this totals approximately 80,000 seeds per acre, or 48,000 live seeds per acre.

On hillside areas natural seedfall, as estimated from 24 seedtraps, amounted to 14,000 seeds per acre with a sampling error of 6,000 seeds at the 95 percent level. Viability of this seed is unknown but, for further discussion, will be assumed to average 60 percent. Thus, natural seedfall is estimated to average 8,400 live seeds per acre.

1/ Isaac, L. A. Life of seed in the forest floor. U.S. Dept. Agr., Pacific Northwest Forest and Range Expt. Sta., Forest Res. Note 31, p. 14, 1940

2/ U.S. Forest Serv. Woody-plant seed manual. U.S. Dept. Agr. Misc. Publ. 654, 416 pp., illus., 1948.

Seedlings Per Acre

Natural seedfall was assumed to be equal on adjacent cutover areas; the difference in seedling numbers was attributed to aerial seeding. Thus, aerial seeding is assumed to have produced an average of 760 seedlings per acre on the south-facing hillside, 940 seedlings per acre on the north-facing hillside, and 510 seedlings per acre on the valley bottom (fig. 2).

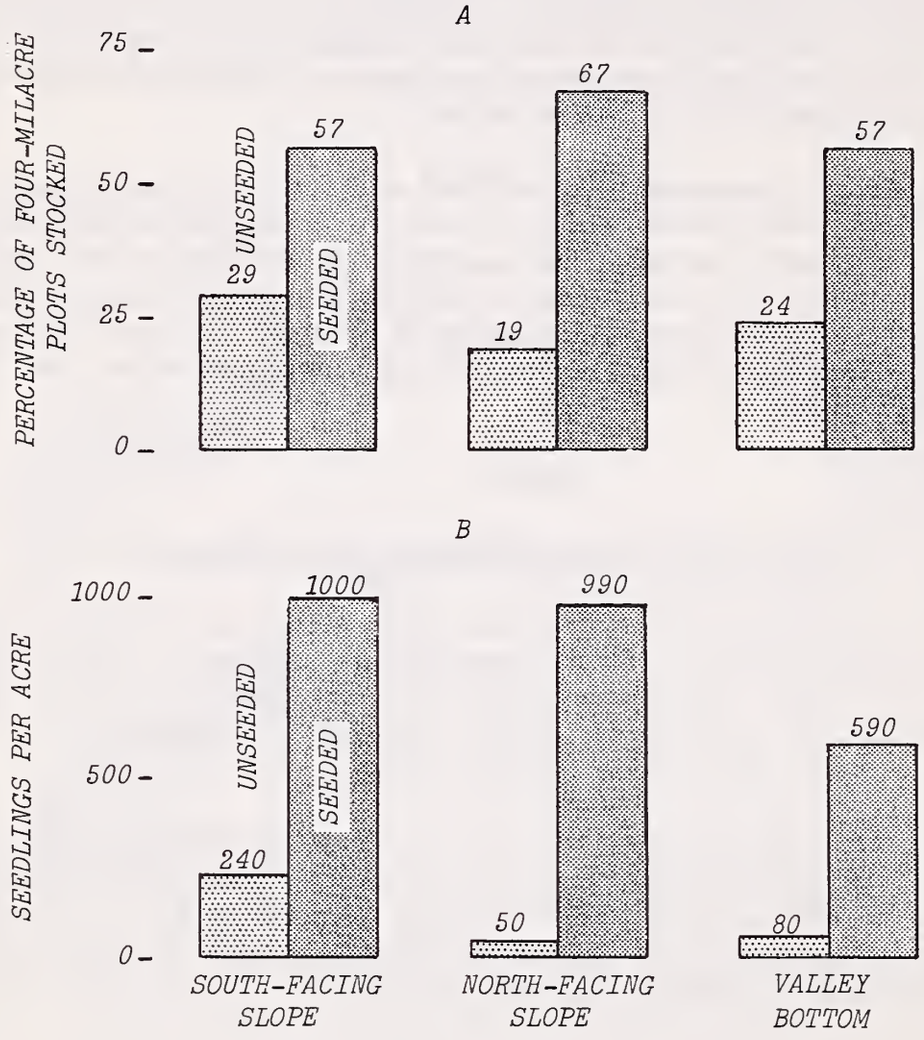

Figure 2. — Western hemlock and Sitka spruce seedlings germinating in 1961 on seeded and unseeded cut-over land near Sitka, Alaska.
A, Percentages of four-milacre plots containing at least one seedling.
B, Number of seedlings per acre.

Fewer seedlings were established on the valley bottom than on hillsides. The reason for this is unknown but poor drainage may be a major factor. During the survey heavy rains occurred and large puddles formed, many containing submerged live seedlings. Such flooding is temporary but occurs frequently during the fall when seed is on the ground. Reduced survival appears probable under these conditions.

Seed-to-Seedling Ratio

A strict accounting of seed and seedlings is impossible because of the many assumptions and estimates made. With these limitations in mind, two methods were used to estimate the number of live seeds needed to produce one seedling surviving through the first growing season on north- and south-facing slopes combined. Both methods yielded similar results:

First, a net average of 850 seedlings per acre survived from 48,000 live seeds per acre sown, a ratio of 1: 56.

Second, a total average of 995 seedlings per acre survived from 56,400 live seeds per acre provided by both aerial and natural seeding, a ratio of 1: 57.

Stocking

Percentage of plots stocked (stocking percent) is a measure of seedling dispersal over an area and therefore offers another way to judge the effectiveness of aerial seeding. In this test a 4-milacre plot was considered stocked if it contained at least one 1961 seedling. Eliminating the effect of natural seedfall, 1961 seedlings originating from sown seed were present on 28 percent of the plots on the south-facing slope, 48 percent of the plots on the north-facing slope, and 33 percent of the plots on the valley bottom (fig. 2).

Stocking resulting from sown seed was below the 40 percent considered satisfactory by Region 10, U. S. Forest Service, on the south-facing slope and valley bottom, and was satisfactory on the north-facing slope. Natural regeneration combined with this to complete satisfactory stocking of all seeded areas with seedlings germinating in 1961. Seedlings were well distributed on all three aspects. Distribution on the valley bottom, as measured by stocking percent, did not differ significantly from the sidehills despite the fewer seedlings per acre on the valley bottom. Apparently seedbed conditions were suitable for germination and survival in much the same pattern on all three aspects.

Species Composition of 1961 Seedlings

Species composition of 1961 seedlings was determined from the number of seedlings on seeded and unseeded cutover areas (table 1). By

Table 1.--Total number of 1961 hemlock and spruce seedlings on 75 one-milacre sample plots on seeded and unseeded cutover land by aspect, Katlian Bay, Alaska

Aspect	Seeded		Unseeded	
	Hemlock	Spruce	Hemlock	Spruce
South-facing	35	40	18	0
North-facing	45	29	4	0
Valley Bottom	24	20	3	3

subtracting the number of seedlings on unseeded paired areas, the species composition of 1961 seedlings resulting from sown seed was determined to be 52 percent spruce and 48 percent hemlock. This compared closely with the percentage composition of sown seed: 58 percent spruce and 42 percent hemlock, indicating that seed of the two species became established almost equally well.

Conclusions

Aerial seeding of one-third pound of mixed hemlock and spruce seed per acre, yielding an average of 48,000 live seeds per acre, was insufficient to restock all areas to a minimum acceptable level of 40 percent. However, 56,000 live seeds per acre, a figure roughly equal to natural seedfall and sown seed combined, was more than adequate. Approximately 60 live seeds were required to produce each seedling surviving at the end of the first growing season. Fewer seedlings became established as a result of seeding on the valley bottom than on nearby north- and south-facing hillsides, although distribution as indicated by stocking percent was not significantly different. Poor drainage on the flat valley bottom may be a cause of lower germination or survival.

Seedbed conditions change rapidly after logging as brush, forbs, and moss become established on mineral soil; therefore, similar results could not necessarily be expected if more time elapsed between logging and seeding. Seedbed conditions would also be different following logging by methods other than high-lead or tractor, or following a burn. However, under conditions reported here, aerial seeding appears to offer a satisfactory means of attaining regeneration when an adequate natural seed source is not available.

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